Title
Route-Specific Survival of Juvenile Salmon Migrating through the Sacramento-San Joaquin Delta

Author
Perry, Russell W

Publication Date
2010-07-07

Peer reviewed

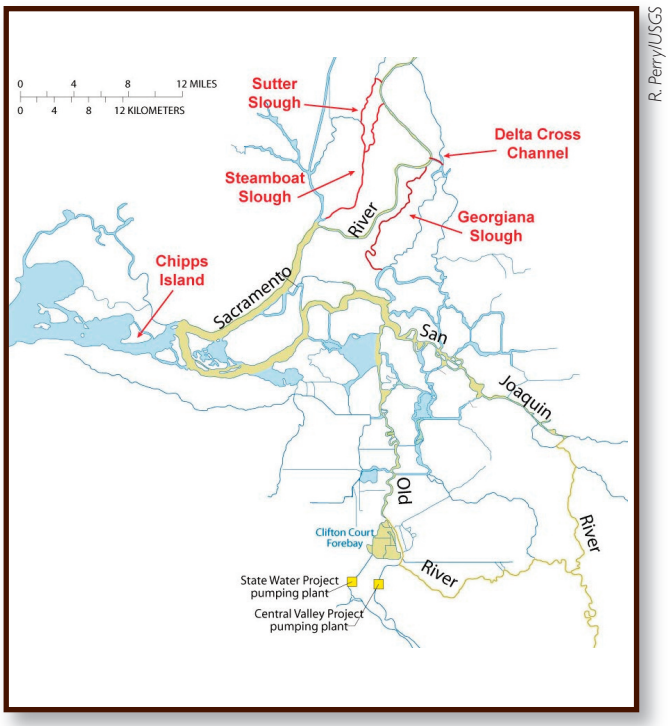
DELTA SCIENCE PROGRAM

Route-Specific Survival of Juvenile Salmon Migrating through the Sacramento-San Joaquin Delta

Russell W. Perry, Western Fisheries Research Center, U.S. Geological Survey

SUMMARY

How effective is closing the gates of the Delta Cross Channel in preventing young salmon from entering the interior of the Sacramento- San Joaquin Delta, where water diversions occur and salmon mortalities are high? What other factors influence a migrating salmon's chances of making it to sea? This project examined these questions by tagging and tracking more than a thousand juvenile Chinook salmon released into the Sacramento River. The data were used to estimate salmon survival rates along different migration routes and their relation to the operation of the cross channel, flow rates and tides, among other things. A subsequent model has been developed for predicting the effects of future water management actions on salmon.



R. Perry/USGS

A map of the Sacramento-San Joaquin Delta with relevant features for the project noted.

PROJECT

In the first phase of the project, the Delta Science fellow and colleagues designed a network of acoustic telemetry listening stations, strategically placed along four major migration routes linking the Sacramento River to Chipps Island, where all the region's salmon runs converge. Two of these routes avoided the delta's interior, one following the main stem of the Sacramento River, the other crossing two dredged, diked and leveed channels known as Sutter and Steamboat sloughs. Of the two routes through the delta's interior, one traversed the Delta Cross Channel, whose gates are opened to divert Sacramento River water into the delta's interior. The other passed through the natural Georgiana Slough, just downstream of the cross channel.

Chinook salmon, also known as king salmon, are of particular relevance to wildlife managers, as two of the four salmon runs in the Sacramento watershed (the winter-run and spring-run) are protected by the Endangered Species Act. The collapse of unlisted Central Valley fall-run Chinook salmon, now categorized as "a species of concern," triggered the closure of the West Coast salmon fishery in 2008 and the subsequent declaration of the fishery as a federal disaster in 2008 and 2009. The Central Valley late-fall run Chinook, which was studied in this project, is also a species of concern.

A leaping Chinook salmon.
D. Killam/DFG

In 2006–07, about 146 tagged late-fall run Chinook salmon yearlings from the Coleman National Fish Hatchery were released into the Sacramento River near Sacramento and tracked to Chipps Island. Fish survival rates were calculated along each route, along with the fraction of fish on each route, to estimate population-level survivorship. With the first year of data, the fellow was able to fine-tune the positioning of the telemetry stations to better capture fish movements, travel times and survival rates. From 2007 to 2009, the U.S. Fish and Wildlife Service, in collaboration with NOAA Fisheries, released more than 1,000 tagged yearlings (all with fork lengths greater than 140 millimeters) and tracked them acoustically through the array of carefully positioned telemetry stations.

RESULTS

As expected based on previous studies, salmon that entered the delta's interior fared worse than those that stayed on the main stem of the Sacramento River. Specifically, salmon migrating along the Sacramento River were between 1.5 and 6.6 times more likely to reach Chipps Island than fish attempting to navigate the delta's interior.

The fraction of fish entering the delta's interior ranged from 9% to 39% during the course of the study and was found to vary

hourly with the tides. Strong flood tides were shown to reverse the river's direction and literally push fish into the interior of the delta. Higher river flows were observed to dampen the effects of tidal currents on fish.

The position of the gates of the Delta Cross Channel also influenced a fish's chances of being entrained into the delta's interior, but less than expected given the huge volume of water that the gates control. In particular, with the gates open, the fraction of water diverted into the delta's interior rises by about 30%. But, this does not mean that with the gates closed, there is a 30% reduction in the number of salmon entering the interior of the delta. Instead, scientists measured an approximately 15% reduction in fish entrainment rates.

Why? Because the cross channel is not the only entry point into the delta's interior. Salmon can also enter via the nearby Georgiana Slough, and based on this project, closing the gates actually increases a fish's chances of entering Georgiana Slough, to the extent that the expected benefits of closing the gates is roughly halved. The interaction between flows in the Sacramento River and tidal currents has roughly the same influence on salmon entrainment rates as the operation of the cross channel.

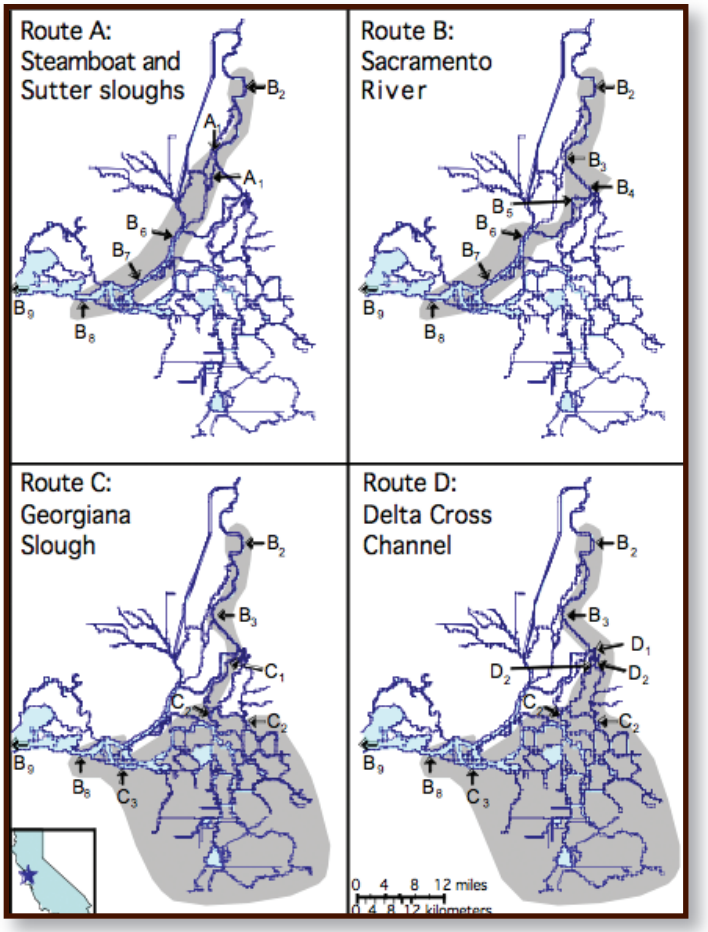
APPLICATIONS

The results from this project show that low flows in the Sacramento River near the junction with the Delta Cross Channel increase a salmon's chance of being entrained into the interior of the delta. Closing the gates of the cross channel can help prevent fish from entering the interior of the delta so long as flows in the river remain high enough to protect fish from tidally driven currents, which may also entrain fish into the delta's interior. Water management actions that reduce flows in the river near the junction with the cross channel are predicted to have a deleterious effect on population-level survival rates of migrating Chinook salmon. The model developed for this project can be used to forecast the impacts of water management actions such as the proposed peripheral canal on the region's salmon.

PUBLICATIONS

Perry, R. W., P. L. Brandes, P. T. Sandstrom, A. Ammann, B. MacFarlane, A. P. Klimley and J. R. Skalski. 2010. Estimating survival and migration route probabilities of juvenile Chinook salmon in the Sacramento–San Joaquin River Delta. North American Journal of Fisheries Management. 30:142–156.

Perry, R. W. and J. R. Skalski. 2009. Migration and survival of juvenile Chinook salmon through the Sacramento–San Joaquin River Delta during the winter of 2007-2008. Technical Report to U.S. Fish and Wildlife Services, Stockton, California. http://www.fws.gov/stockton/jfmp/datareports.asp



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Maps of the Sacramento-San Joaquin Delta with shaded regions showing the four major migration routes along which fish were acoustically tracked. The "A" series represent points along Sutter and Steamboat sloughs; the "B" series, along the Sacramento River; "C" the Delta Cross Channel and "D" the route through Georgiana Slough.

MENTORS

Research: Professor John Skalski, School of Aquatic and Fishery Sciences, University of Washington, Seattle

Community: Fish biologist Patricia Brandes, U.S. Fish and Wildlife Service, Stockton

CONTACT

Russell W. Perry
Western Fisheries Research Center
U.S. Geological Survey
(509) 538-2299 ext. 242
rperry@usgs.gov

Sea Grant
Delta Stewardship Council

This publication is sponsored by a grant from the Delta Science Program, part of the Delta Stewardship Council. The views expressed herein are those of the authors and do not necessarily reflect the views of the Delta Stewardship Council or any of its sub-programs. This document is available in PDF on the California Sea Grant website: www.csgc.ucsd.edu.

California Sea Grant, University of California, San Diego, 9500 Gilman Drive, Dept. 0232, La Jolla, CA 92093-0232
Communications Phone: 858-534-4440